BAYESIAN DECISION THEORY APPLIED TO DEEP SKY STAR IDENTIFICATION

DANIEL S. CLOUSE
CURTIS W. PADGETT

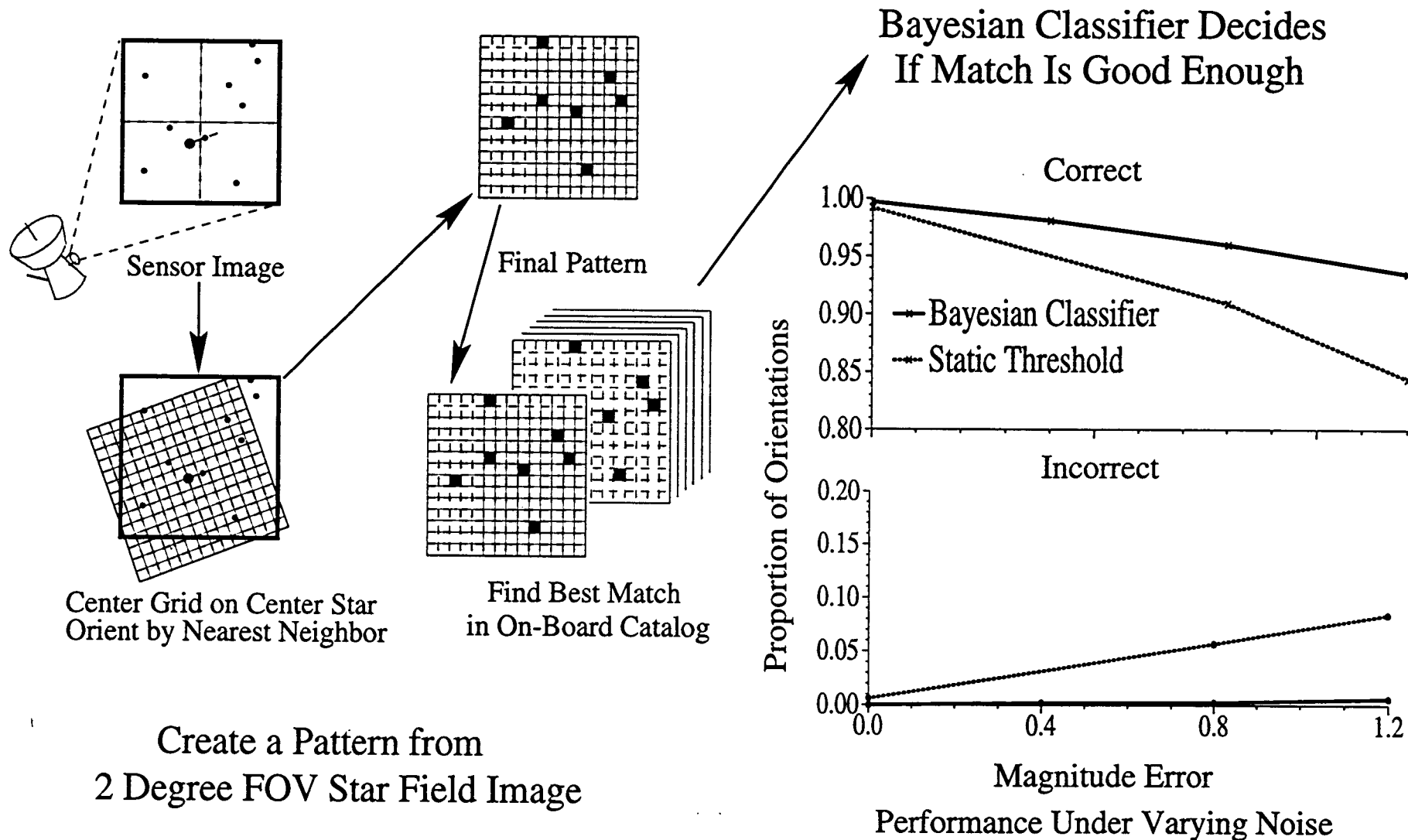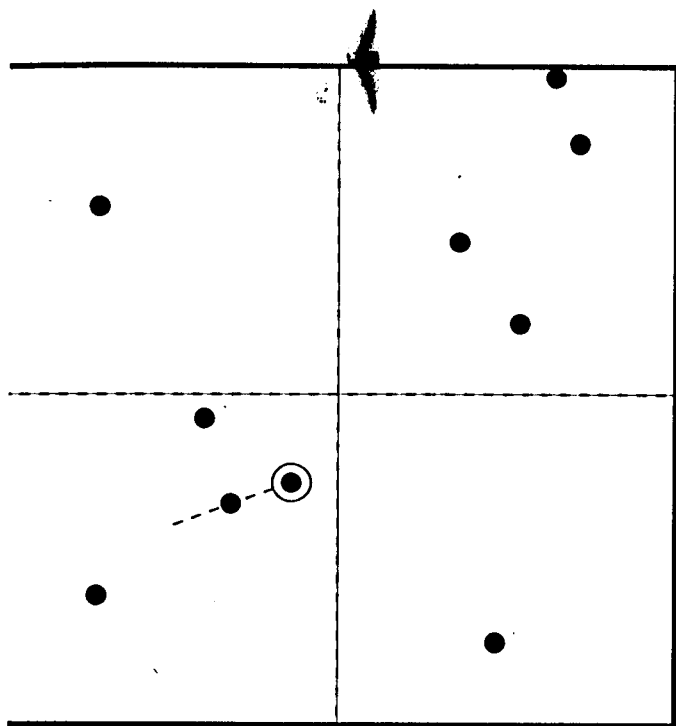**JPL**

APRIL 1997

CENTER FOR SPACE MICROELECTRONICS TECHNOLOGY
JET PROPULSION LABORATORY, CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA 91109

Grid Algorithm Finds Spacecraft Attitude
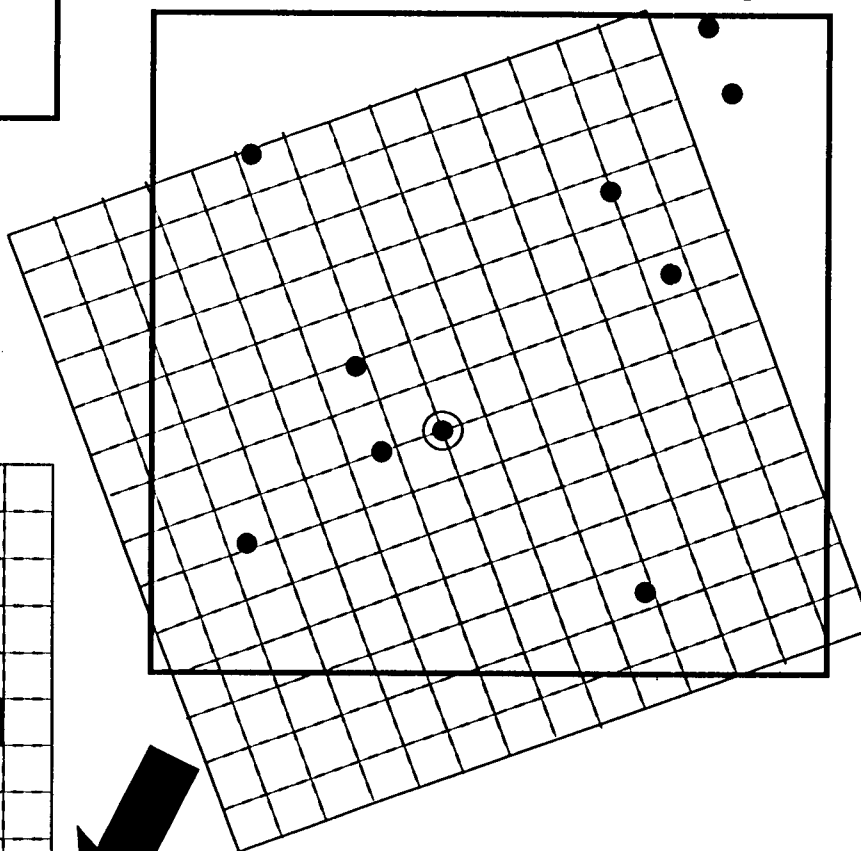# Using Small FOV Science Camera
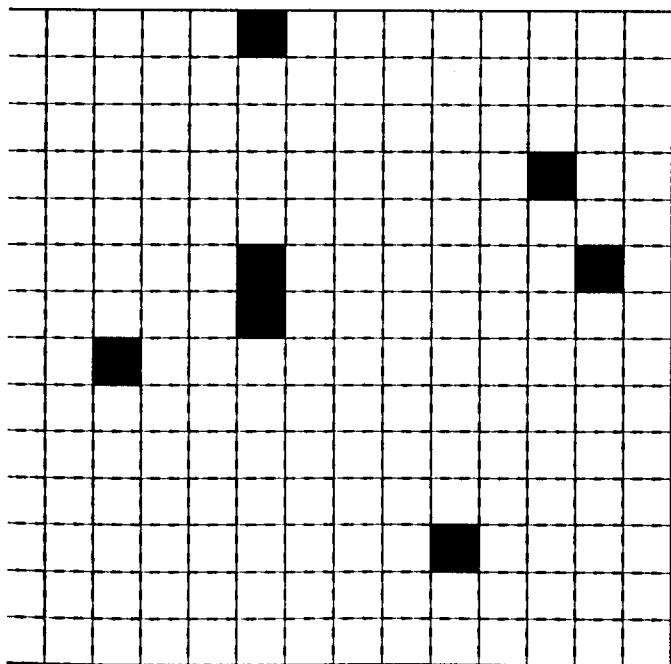## (Dim Star)

Sensor Image

Center Grid on Center Star
Orient by Nearest Neighbor

Create a Pattern from
2 Degree FOV Star Field Image

Final Pattern

Find Best Match
in On-Board Catalog

Bayesian Classifier Decides
If Match Is Good Enough

Correct

— Bayesian Classifier
··· Static Threshold

Incorrect

Proportion of Orientations

Magnitude Error

Performance Under Varying Noise

Creating a Pattern

Sensor Image

Center Grid on Center Star
## Orient by Nearest Neighbor

Final Pattern

Problem Statement

Identify the orientation of small FOV (field of view) science camera ($2°$) from a single star field image with no prior knowledge of orientation.

– Using science camera reduces weight, thus cost.

– But increases difficulty of problem:
  1. fewer stars in FOV
     - can fix w/ longer integration times
     - sims use all stars brighter than 10.5 mag
  2. more possible FOVs to choose from

– Grid algorithm works well with medium FOV ($4°$) Handles reasonable noise.

Goal: Make grid algorithm work with small FOV.
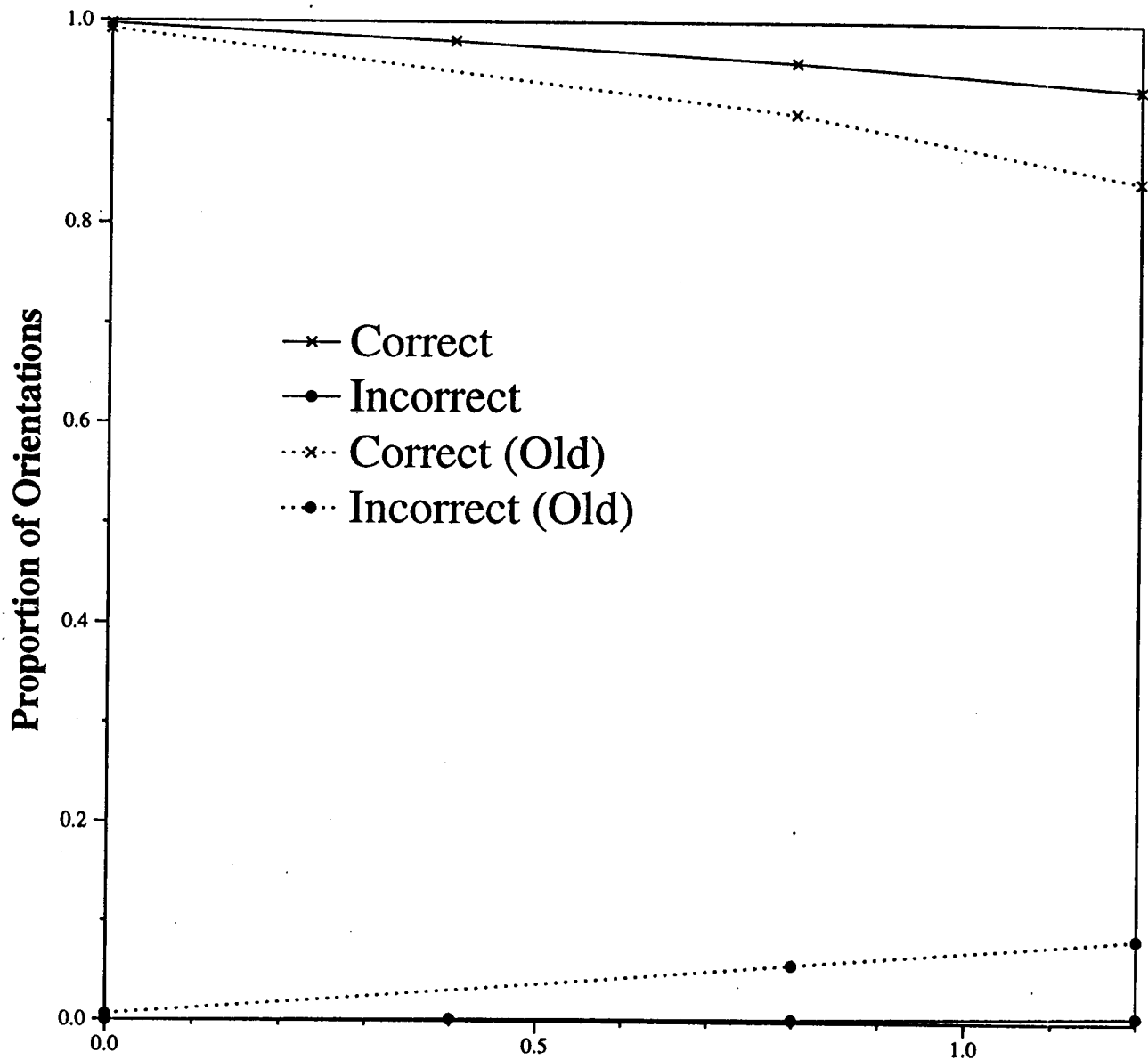
Why Adaptive Threshold?
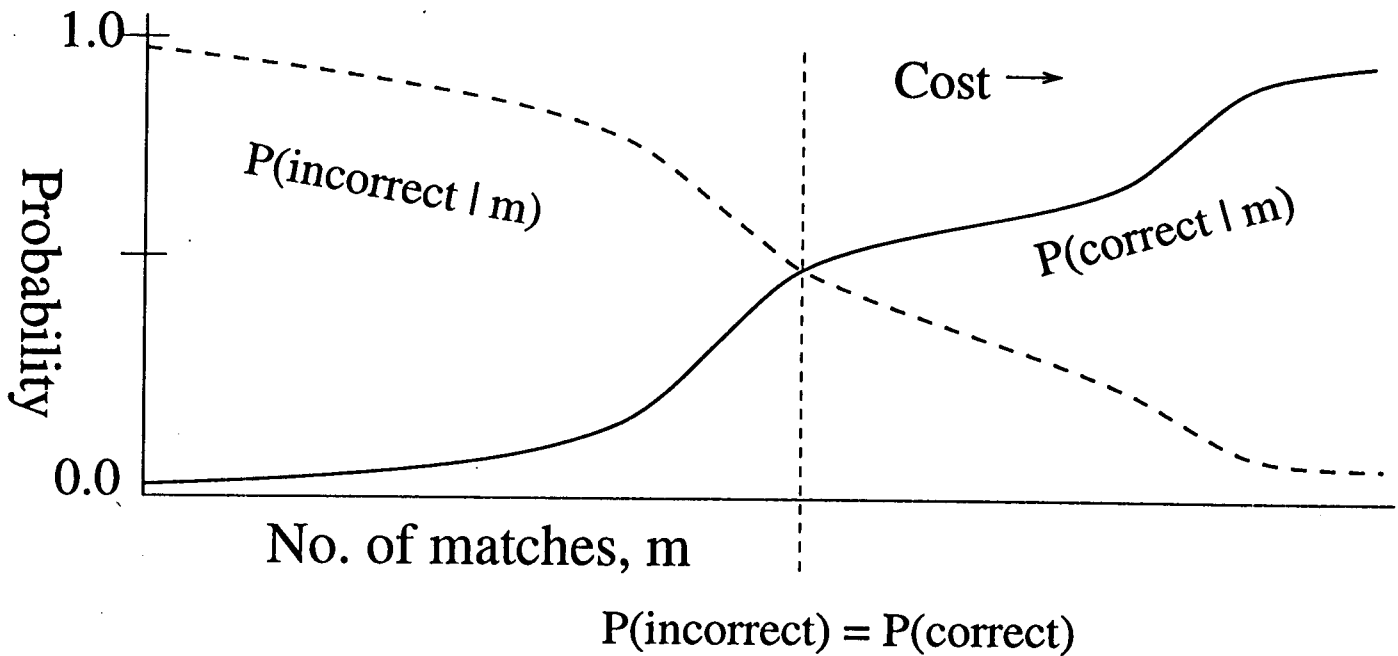
- Set threshold, T, at point where P(incorrect) = P(correct)

- But the number of stars in a FOV varies greatly
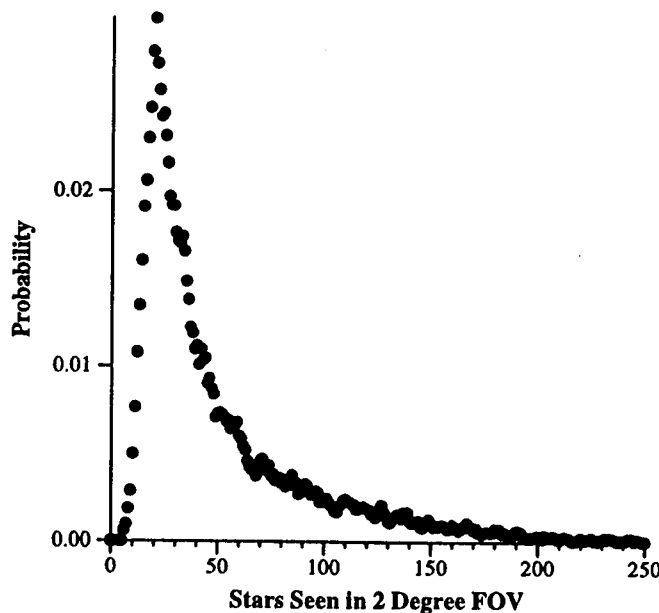
- It's easier to get 10 matches out of 200 than out of 10
  So T needs to vary with the number of stars in the FOV

for Stellar Magnitude Increases (pixel error 0.5)

Dynamic Algorithm Performance (L=0.5)

Future Work:

Can we improve algorithm performance?
- Analytical characterization of distributions
- Bring verification into Bayesian framework

How will algorithm perform with smaller FOV?

- Requires deeper catalog

- Information proportionally less reliable

Will it work with real star images?